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14. ABSTRACT  This report results from a contract tasking Slovak Academy of Sciences as follows: The contractor will investigate the evolution of large-scale solar magnetic fields. A direct comparison of coronal holes and magnetic neutral lines from 1976 to the present will be extrapolated back to 1947 using magnetic neutral line measurements from the Astronomical Institute to determining the relationship of coronal holes with solar magnetic neutral lines over the 50 years from 1947 to the present.					
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Final report for contract SPC 99-4014

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THE CONTRACT ORDER NUMBER, F61775-99-WE014  
"Extrapolation of Neutral Line Data from the Green Corona  
Since 1976 Back to 1947"

Comparison and Cross-Calibration of the Green Coronal Data from Astronomical Institute of the Slovak Academy of Sciences with Measurements from Coronal Stations at Sacramento Peak Observatory (USA) and Norikura (Japan)".

In order to do cross-calibration of the green coronal line intensity (Fe XIV) made at different coronal stations over the world, especially in the period 1939-1976 and put them into the one photometric scale (Lomnický štít), we need to collect these data from Solar Geophysical Data and/or Quarterly Bulletin on Solar Activity and put them into the computer in a digital form. Up to date, the following work has been made:

- 1/ Collection of all coronal data from Kislovodsk coronal station (Russia). This station has been added into the program due to its long duration in observations of the green corona intensities.
- 2/ Collection of all data from Pic du Midi Observatory (France).
- 3/ Collection of all data from Norikura coronal station (Japan). Data in items 1-3 are ready for other analysis (comparisons between individual coronal stations).
- 4/ Collection of data from Wendelstein (Germany) and Arosa (Switzerland) coronal stations. These stations have been also added to our analysis, to have as more as possible observational data in 1939-1976 years.
- 5/ Data from Sacramento Peak Observatory are continuously put into the computer.
- 6/ I have managed my business trip to Japan to discuss the method of observations in detail. This coronal station has a long data set (1950-to present), however, they changed their method of observations for several times, and obtained results are disputable.
- 7/ Some correlations between the coronal index of solar activity and other solar indices have been made for the last years (1996-2000), and obtained results show very good correlations, especially with total solar irradiance.

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We would like to particularly present these results during the forthcoming 'World Space Congress 2002', held in Houston (October 10-20). The coronal index of solar activity is computed from homogeneous coronal data set based on observations of the green corona intensities made over the world and transferred into the one photometric scale (Lomnický stit).

## 1. TARGETS

As we stated in our proposal, the target was:

1/ To compare Stanford magnetic data of the Sun with brightness and time-latitudinal variation of the green corona intensities over the period 1976 to present (1999/2000) and to use the correlations for this period to obtain neutral magnetic lines back to 1947 (1939) corresponding to the earliest observations of the green corona.

2/ As an alternative or additional way of determining the evolution of the large scale neutral line over time we proposed to study coronal hole areas (low brightness regions in the green corona) and compare it with the Stanford derived "tilt angle". Again, the approach was to obtain correlations for the 1976-1999 period and extrapolate back to obtain the tilt angle for earlier time periods.

## APPROACH

1/ To compare both the green line brightness (from our Institute) and magnetic data (Stanford) we:

- a/ prepared homogeneous coronal data set over the years 1997-1999
- b/ down-loaded Stanford data from web over the period 1976-1999.

2/ Coronal holes were computed from homogeneous coronal data set over the entire period of study 1939-1999 (60 years).

3/ Coronal index of solar activity has been extended for 1998 and 1999.

4/ The time-latitudinal distribution of the green corona intensities was prepared for 1997-1999.

5/ Special software was developed to compare distribution of the green corona brightness and magnetic data from Stanford data at all positional angles and heliographic longitudes for each Carrington rotation.

6/ Visual checking between the corona brightness and magnetic field strength since 1976 to 1999 (of about 300 Carrington rotations) to find regularities.

- 7/ Computation of the relation between the green line intensities and magnetic field polarity.

## RESULTS

- 1/ The "tilt angle" evolution over the solar cycle tracks that other indicators of solar activity such as sunspot number, coronal branches of increased intensities.
- 2/ Some similarities also exist between the distribution of the green coronal holes and the "tilt angle", in general.
- 3/ a/ We have found good a relation between the averaged green line intensities and magnetic field strength. These computation was made in the heliographic interval plus/minus 45 degrees. This relation enable us to extrapolate a magnetic field strength intensities (Stanford scale) since 1976 to 1943 (1939). It shows that over the entire observational period magnetic field strength increased at all solar maxima, except for solar cycle 23 (the present cycle).
- b/ The correlation between the magnetic field strength and coronal intensities at high latitudes (50 - 70 degrees) has an opposite course to that obtained for case a/. However, the coronal intensities and magnetic fields are very low in these high-latitude regions, so we omitted them from the following calculations.
- 4/ There is no relation between the magnetic polarity and coronal brightness as was supposed before. This is a reason why we can not compute solar surface field at 2.5 solar radii.
- 5/ To do this, distribution of the green corona should be compared with the distribution of filaments to derive the polarity (filaments or prominences are located above the neutral line) of magnetic fields. Then it should be possible to derive the 'neutral line' as is computed from Stanford data (Hoeksma method). However, all this procedure is out of the scope of this contract, and we are not able to estimate how long would it take. To do this, position of filaments would need to be obtained to collect from the Quarterly Bulletin on Solar Activity, or from Meduon Observatory. Nevertheless, this solution should be done in future anyone in the world.
- 6/ All the above obtained results are being prepared for a publication. An outline of the paper is being sent to Dr. Cliver, as a co-author of the paper.
- 7/ The obtained results (homogenepous coronal data set, coronal index of solar activity, areas of coronal holes) will be used in other papers related

to the research of the solar corona over cycles.

Tatranska Lomnica, December 29, 2000

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